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NASA
National Aeronautics and Space Administration

Goddard Space Flight Center
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1986
MISSIONS

61-C/MSL-2 SATCOM KU-1 GAS BRIDGE

Launch Vehicle – Space Transportation System (STS) - Space Shuttle Columbia.

Program Overview – Space Shuttle is a true aerospace vehicle. It takes off like a rocket, maneuvers in Earth orbit like a spacecraft, and lands like an airplane. It is designed to carry heavy loads into Earth orbit. The Space Shuttle can be used again and again.

Moreover, Shuttle permits checkout and repair of unmanned satellites in orbit or return of the satellites to Earth for repairs that could not be done in space.

Interplanetary spacecraft also can be placed in orbit by the Shuttle, together with a rocket stage called the Inertial Upper Stage (IUS). Following deployment from the Shuttle, the IUS is ignited to accelerate the spacecraft into deep space.

The Shuttle flight system is composed of the orbiter, an external tank (ET) and two solid rocket boosters (SRBs). Each booster rocket has a sea level thrust of 2.6 million pounds (11.6 million newtons). The orbiter and SRBs are reusable, and the external tank is expended with each launch.

The orbiter is 122 feet (37 meters) long and 57 feet (17 meters) high, with a wingspan of 78 feet (24 meters) and a weight, without fuel or payload, of 150,000 pounds (68,000 kilograms). It is about the size and weight of a DC-9 commercial air transport.

The orbiter can transport a payload of 65,000 pounds (29,500 kilograms) into orbit. It carries its cargo in a payload bay 60 feet (18.3 meters) long and 15 feet (4.6 meters) in diameter.

The orbiter's three main liquid-fueled engines each has a thrust of 470,000 pounds (2.1 million newtons). They are fed propellants from the external tank which is 154 feet (47 meters) long and 28.6 feet (8.7 meters) in diameter.

At liftoff, the external tank holds 1,550,000 pounds (703,000 kilograms) of propellants, consisting of liquid hydrogen (fuel) and liquid oxygen (oxidizer). The hydrogen and oxygen are in separate pressurized compartments of the external tank.

The crew occupies a two-level cabin at the forward end of the orbiter. The crew controls the launch, orbital maneuvering, atmospheric reentry and landing phases of the mission from the upper level flight deck. Payload handling is accomplished by crew members at the aft cabin payload station. A living area is provided on the lower deck.

Crew members experience a designed maximum gravity load of only three Gs during launch and less than 1.5 Gs during a typical reentry.

Landing speed for the orbiter is 210 miles (335 kilometers) an hour. A Shuttle crew can be as many as seven people.

NASA's Lyndon B. Johnson Space Center in Houston, TX, manages the Space Shuttle program and is responsible for development, production, and delivery of the orbiter. The astronaut office is located at this NASA center.

NASA's Goddard Space Flight Center in Greenbelt, MD, is responsible for space communications.

NASA's George C. Marshall Space Flight Center in Huntsville, AL, is responsible for the development, production, and delivery of the solid rocket boosters, the external tank and the orbiter main engines. Test firings of the Shuttle engines are carried out at NASA's John C. Stennis Space Center in Bay St. Louis, MS.

NASA's John F. Kennedy Space Center, FL, is responsible for design and development of launch and recovery facilities and for operational missions requiring eastern launches.

Project Objectives – The 24th flight of America's Space Transportation System was the first flight for the orbiter Columbia in two years, since STS-9. Robert L. "Hoot" Gibson commanded this mission. Joining Gibson were pilot Charles F. Bolden and mission specialists Franklin R. Chang-Diaz, Steven A. Hawley, and George D. "Pinky" Nelson. Chang-Diaz was the first Hispanic American to journey into space. The two payload specialists were Robert J. Cenker of RCA and Florida U.S. Rep. Bill Nelson.

The primary payload carried aboard Columbia was the RCA Satcom K-1 communications satellite, the second in a series of three, with its Payload Assist Module (PAM) D-2 upper stage. Also aboard Columbia in the payload bay were the Materials Science Laboratory-2 (MSL-2); the first Hitchhiker (HG-1) payload; the RCA Infrared Imaging Experiment (IR-IE); and 13 Get Away Special (GAS) Experiments in specialized canisters, 12 which were mounted on a GAS bridge which was attached to the payload bay.

Payload Descriptions – The Satcom K-1 has 12 channels operating at a 54-MHz usable bandwidth. The spacecraft was designed to provide coverage to the continental 48 states or to either the eastern half or western half of the country.

The second of the planned fleet of three communications satellites operating in the Ku-band part of the spectrum, this new generation of spacecraft carries 45-watt transponders, which permits the use of Earth station antennas as small as 3 feet (.9144 meters) in diameter. Satcom K-1 was assigned an orbital position of 85 degrees west longitude.

The MSL-2, sponsored by the Marshall Space Flight Center, Huntsville, AL, was controlled by onboard computers that contained three materials processing experiments operated by Chang-Diaz. Samples of a variety of materials were carefully observed while they were melted and solidified in zero gravity.

The HG-1, sponsored by the Goddard Space Flight Center, Greenbelt, MD, was mounted to the side of the payload bay and supported three experiments. One of the experiments was the Particle Analysis Cameras for the Shuttle (PACS) experiment which provided film images of any particle contamination around the Shuttle in support of future Department of Defense infrared telescope operations. Another experiment was the Capillary Pump Loop which provided a zero-gravity test of a new two-phase heat transport system. The third experiment, the Shuttle Environment Effects on Coated Mirrors (SEECM), was a passive witness mirror-type experiment which determined the effects of contamination and atomic oxygen on ultraviolet optics material.

The GAS Bridge Assembly, sponsored by the Goddard Space Flight Center, was flown for the first time on 61-C. It contained twelve Get Away Special (GAS) canisters with the following experiments:

The Alabama Space and Rocket Center co-sponsored three student-developed experiments called Explorer: solidification of lead-antimony and aluminum-copper alloy, growth of potassium-tetracyanoplatinate hydrate crystals in an aqueous solution, and germination of radish seeds. A fourth experiment by the Marshall Amateur Radio Club was also flown.

The Penn State/GE payload conducted four experiments: liquid slosh, liquid droplet heat radiator, convection, and surface tension.

A United States Air Force Academy cadet-built experiment, called Scenic Fast, was designed to determine the dynamics of an aluminum alloy beam in a zero-g environment.

The Brine Shrimp Artemia experiment, from Booker T. Washington High School, Houston, TX, determined the effects of microgravity on eggs hatched in space. The Fluid Physics experiment, from the High School for Engineering, Houston, TX, examined the behavior of fluid heated in microgravity.

AllTech Associates' Project Joshua attempted to produce experimental evidence supporting a theory on the effect of gravitational forces on particle-size gradient in the manufacture of high performance liquid chromatography analytical columns used for chemical analysis.

The St. Mary's Hospital, Milwaukee, WI, sponsored Project Julie, a set of laser integrated experiments to determine what crystals can be grown by focusing laser radiation upon medications in zero-gravity.

The Ultraviolet Experiments (UVX) from Goddard Avionics Package, Johns Hopkins University, and University of California–Berkeley, performed measurements of the galactic and extra-galactic contributions to the Diffuse Ultraviolet Background Radiation in the 350–6,000 Angstrom region.

The Vertical Horizons experiment will determine how unprimed canvas, prepared linen canvas, and portions of canvas react under space conditions and identify any accelerated degradation of the experimental samples caused by the cumulative effects of vibration, temperature change, g-force stress, and radiation from short-term space flight.

The Canada Centre for Space Science, National Research Council of Canada, sponsored the Photometric Thermospheric Oxygen Nightglow Study (PHOTONS) as an experiment to measure O and O_2 continuum emissions in the terrestrial nightglow and in the shuttle nightglow.

The GAS Bridge Electronic Monitoring System was an experiment to measure the environment of the GAS bridge through the use of strain gages and accelerometers.

In addition to the experiments flown on the GAS bridge, an additional experiment sponsored by the U.S. Department of Agriculture was flown from an attached GAS can on the aft starboard still of the orbiter This experiment studied gypsy moths and engorged female American dog ticks to determine the effect of weightlessness on egg hatching.

The IR–IE infrared camera was developed by RCA and was under the supervision of Cenker during the mission. Its purpose was to acquire radiometric information that appears within the field of view of the self-contained optical system. RCA hoped to photograph storms, volcanic activity or other natural occurrences during the mission as well as map the orbiter's payload bay to determine its thermal characteristics at various times on orbit.

Middeck payloads included the Comet Halley Active Monitoring Program (CHAMP), Initial Blood Storage Experiment (IBSE) and three student experiments.

This was the first of several Shuttle flights on which the CHAMP experiment was flown to obtain photographs and spectra of Halley's Comet as well as its dynamic and structural behavior and its chemical structure.

IBSE, funded by Johnson Space Center, with the Center for Blood Research, Boston, MA, acting as the lead institution, studied blood storage and sedimentation characteristics in microgravity.

The experiments for the Shuttle Student Involvement Project (SSIP) were called Measurement of Auxin Level and Starch Grains in Plant Roots, Air Injection as an Alternative to Honeycombing, and A Study of Paper Fiber Formation in Microgravity.

Payload Specialist Bill Nelson participated in the University of Alabama at Birmingham Comprehensive Cancer Center experiment. The object of the experiment was to try to grow crystal proteins in space for cancer research.

Significant modifications were made on the orbiter Columbia in order to accommodate the three research experiments developed by the Langley Research Center, Hampton, VA. The following experiments were designed to measure orbiter aerodynamic and aerothermodynamic characteristics during reentry: Shuttle Infrared Leeside Temperature Sensing (SILTS), Shuttle Entry Air Data System (SEADS) and Shuttle Upper Atmosphere Mass Spectrometer (SUMS).

Project Results – Discovery was launched from the Kennedy Space Center (KSC), FL, at 7:00 a.m., EST, on January 12, 1986. Six unscheduled events impacted the launch date:

December 18 - The launch was slipped 24 hours due to ground processing and scheduling delays.

December 19 - The launch countdown was stopped by the ground launch sequencer due to hydraulic power unit (HPU) turbine overspeed of the right solid rocket booster. The HPU was replaced.

January 6 - The launch was aborted by the ground launch sequencer due to liquid oxygen ground servicing valve failure. The valve was replaced.

January 7 - The launch was delayed 48 hours due to haze and fog at the transatlantic abort sites.

January 8 - Troubleshooting of the Space Shuttle Main Engine #2 liquid oxygen pre-valve found it to hangup in a closed position. The valve was replaced.

January 10 - The launch was delayed 24 hours due to rain and low visibility at KSC.

Discovery's crew successfully deployed the mission's primary payload Satcom K-1 for RCA American Communications, Inc. Following the launch of Satcom K-1, it was placed into a 23,000 mile (37,013 kilometers) geosynchronous orbit. After this, the 280-square-foot (26.01 square-meters) solar panels were deployed from the 67-by-84-by-60-inch (170.18-by-213.36-by-152.4 centimeters) main spacecraft structure. The spacecraft was then tested for in-orbit operation and locked into its orbital slot.

Both the MSL-2 and CHAMP were activated successfully. HHG-1, the GAS Bridge (12 can canister), GAS can, IR–IE, IBSE, and SSIP experiments operated successfully.

During the mission, Chang-Diaz produced a videotape in Spanish for live distribution to audiences in the United States and Latin America via the NASA Select television circuit.

Mission 61-C was scheduled to be the first KSC landing since mission 51-D on April 19, 1985, when Discovery's right main landing gear tire experienced a blowout. On January 16 and 17, the landing was postponed due to low visibility at KSC. On January 18, the landing was diverted to Edwards Air Force Base, CA, due to inclement weather at KSC.

STS 61-C Crew Portrait – left to right: payload specialist Robert J. Cenker, RCA Astro-Electronics; pilot Charles F. Bolden; Florida U.S. Representative Bill Nelson; mission specialist Steven A. Hawley; mission specialist George D. "Pinky" Nelson; commander Robert L. "Hoot" Gibson; and mission specialist Franklin R. Chang-Diaz, the first Hispanic American in space.

STS 51-L/ TRACKING AND DATA RELAY SATELLITE (TDRS) SPARTAN-HALLEY

Launch Vehicle – Space Transportation System (STS) - Space Shuttle Challenger.

Program Overview – See previous Space Shuttle missions.

Project Objectives and Payload – A planned six-day mission commanded by Francis R. "Dick" Scobee (USAF-Ret). Joining Scobee were Michael J. Smith (Cmdr.-USN), Pilot; Ellison S. Onizuka (Maj.-USAF), Judith A. Resnik (Ph.D) and Ronald E. McNair (Ph.D), Mission Specialists; and Gregory Jarvis (Hughes) and Christa McAuliffe (Teacher), Payload Specialists.

Primary payloads were the Tracking and Data Relay Satellite (TDRS–B) and Spartan-Halley, a Goddard Space Flight Center/University of Colorado experiment designed to record ultraviolet light emitted by the comet's chemistry when it is closest to the Sun.

TDRS–B was the second in a series of three communication satellites designed to replace the worldwide system of ground tracking stations. The communications satellites operate with a ground complex at White Sands, New Mexico. Data from other orbiting satellites are transmitted to the TDRS satellites and from the TDRS satellites to White Sands. Commands are sent from White Sands through the TDRS satellites to the other orbiting satellites.

Teacher in Space was to conduct two lessons from space, one entitled, "The Ultimate Field Trip," to allow students an opportunity to compare daily shuttle life with daily life on Earth and the other, entitled, "Where We've Been, Where We're Going, Why?" to demonstrate the advantages of space.

Other activities planned for the mission included a fluid dynamics experiment, a phase partitioning experiment, a radiation monitoring experiment and a student involvement project. The fluid dynamics experiment, to be conducted by Hughes Payload Specialist Greg Jarvis, was to investigate fluid movement in microgravity. The phase partitioning experiment was designed to study the separation of biomedical materials, such as cells and proteins. The radiation monitoring experiment consisted of a hand-held and pocket monitor to measure radiation levels at various times on orbit.

There were three student involvement projects:

1. A direct crystal growth experiment by Richard S. Cavoli, Marlboro High School, Marlboro, NY.

2. Effects of weightlessness on grain formation by Lloyd C. Bruce of Sumner High School, St. Louis, MO.

3. Chicken embryo development in space by John C. Vellinger, of Jefferson High School, Lafayette, IN.

Project Results – Mission was unsuccessful. Challenger exploded 73 seconds after liftoff, killing all seven crew members. Challenger had been scheduled for launch at 9:36 A.M. EST on January 26, 1986, but was delayed 24 hours because of predicted bad weather at the Kennedy Space Center. On January 27, a countdown delay of approximately two hours was required because of a problem with the removal of the crew hatch door lock. On January 28, the liftoff was delayed approximately two hours to allow the weather to warm up and to remove ice. Liftoff occurred at 11:38 A.M. EST.

STS 51-L Crew Portrait – left to right: mission specialist El Onizuka; pilot Mike Smith; Teacher in Space Participant, S. Christa McAuliffe; commander Dick Scobee; payload specialist Greg Jarvis; mission specialist Ron McNair; and mission specialist Judy Resnik. The 51-L mission was unsuccessful. Challenger exploded 73 seconds after liftoff, killing all seven crew members.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA-10)

Launch Vehicle – Atlas E., Manufactured by General Dynamics Convair.

Project Objectives – NOAA-10, identified as NOAA-G prior to launch, was designed to transmit data directly to users around the world for weather analysis. It is the third generation operational spacecraft for the National Environmental Satellite Data and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA). Ground facilities included NESDIS Command and Data Acquisition stations in Fairbanks, Alaska, and Wallops Island, VA; at NESDIS' Satellite Operations Control Center (SOCC) at Suitland, Maryland, and at a data receiving station operated by the Establissment d' Etudes et de Recherches Meteorologiques (EERM) in Lannion, France.

NOAA-10 carried special Search and Rescue (SAR) equipment in support of the COSPAS/SARSAT program, an international effort in which the primary partners are Canada, France, the Soviet Union, and the United States. The program began as a test and evaluation project in September 1982, following the launch of the Soviet navigational satellite, Cosmos 1383, on June 30, 1982. Between 1982 and December 1988, the program helped in saving more than 1,100 lives.

Spacecraft Description – NOAA-10 (NOAA-G) is the third of the Advanced TIROS-N (ATN) spacecraft. These spacecraft are "stretched" versions of the original TIROS-N series of satellites and feature expanded capabilities for new measurement payloads. The spacecraft, including the apogee kick motor (AKM), in the launch configuration, was 193 inches (491 centimeters) high and 74 inches (188 centimeters) in diameter. It weighed 3,774 pounds (1,712 kilograms). On orbit, with the AKM and reaction control equipment expendables consumed, the satellite weighed 2,270 pounds (1,030 kilograms). The spacecraft was built by RCA Astro Electronics.

Spacecraft Payload – Primary instruments on NOAA-10 include: Advanced Very High Resolution Radiometer (AVHRR), provided International Telephone and Telegraph (ITT), for measuring energy emitted from the atmosphere in the infrared spectral band.

TIROS Operational Vertical Sounder System (TOVS), consists of two separate instruments: High Resolution Infrared Radiation Sounder (HIRS/2), built by ITT, to measure radiation in 20 spectral regions, and the Microwave Sounding Unit (MSU), provided by the Jet Propulsion Laboratory, to make temperature profiles of the atmosphere from the Earth's surface to 65,000 feet (20 kilometers).

Space Environment Monitor (SEM), provided by Ford Aeronautics Communications Corporation, is a charged-particle spectrometer designed to provide measurements of the Earth's radiation belts.

Earth Radiation Budget Experiment (ERBE), provided by TRW, to measure Earth radiation energy budget components monthly at the top of the atmosphere and to provide an experimental prototype for an operational ERBE instrument for future monitoring programs.

Search and Rescue - Provided by Canada and France, the instruments have the capability of detecting existing emergency transmitters operating at 121.5 and 243.1 and 406 MHz. Locations of the emergency signals are determined by using Doppler analysis techniques. Reports of distress signals are forwarded to Mission Control Centers in the Soviet Union, Canada, France, and the United States, and relayed to Rescue Coordination Centers, which dispatch rescue units.

Argos Data Collection System (DCS), provided by France, is a random-access system that provides a means for locating floating terrestrial and atmospheric platforms. Approximately 400 platforms transmit data to the satellite. The information collected is transmitted to Earth for additional ground data processing.

Project Results – Launched September 17, 1986 at 8:52 a.m. PST from the Western Test Range in California and placed in orbit with 98.7 degree inclination.

Major Participants –

NASA Headquarters, Washington, DC

Associate Administrator for Space Science and Applications	Burton I. Edelson
Deputy Associate Administrator for Space Science and Applications	Samuel W. Keller
Director, Earth Science and Applications Division	Shelby G. Tilford
Deputy Director, Earth Science and Applications Division	Ray J. Arnold
Manager, Operational Meteorological Satellite Program	James R. Greaves
Manager, Earth Radiation Budget Satellite (ERBS)	George F. Esenwein
Associate Administrator for Space Flight	Jesse W. Moore
Director, Space Transportation Support	Joseph B. Mahon
Manager, Atlas–E Program	Jay A. Salmanson
Director, Ground Network Division	Charles T. Force

Goddard Space Flight Center (GSFC), Greenbelt, MD

Director	Noel W. Hinners
Director, Flight Projects Directorate	William C. Keathley
Metsat Project Manager	Gerald W. Longanecker
Metsat Deputy Project Manager	Charles E. Thienel
Deputy Project Manager, TIROS	Lawrence T. Draper
Deputy Project Manager, Resources	John A. Underwood
ERBE Project Manager	Carl L. Wagner
Search and Rescue Mission Manager	Fred Flatow
Spacecraft Systems Manager	Gay Hilton
Spacecraft Manager	William M. Peacock
Launch Vehicle Manager	John F. Corrigan
Mission Operations Manager	David A. Coolidge

National Oceanic and Atmospheric Administration (NOAA)

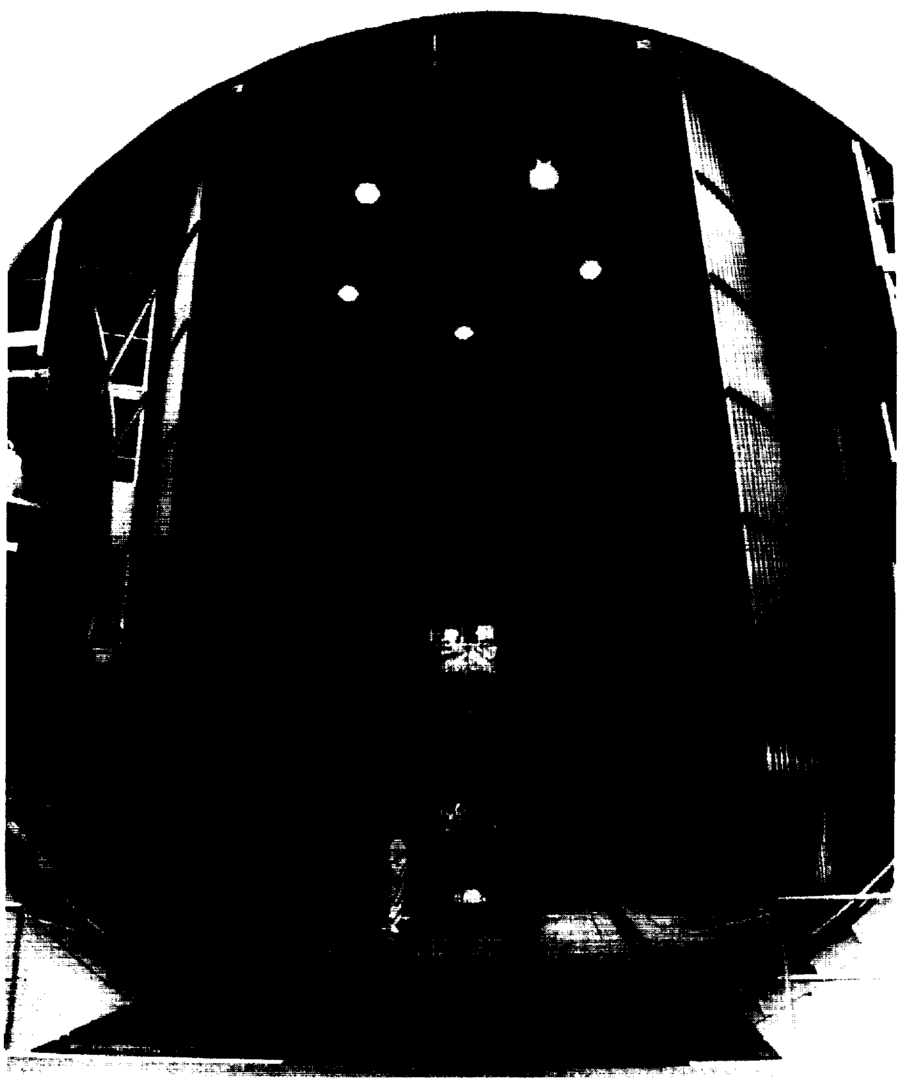
Assistant Administrator for National Environmental Satellite Data and Information Service (NESDIS)	William P. Bishop (Actg.)
Director, Office of Operations	E. Larry Heacock
Chief, Ocean and Atmosphere Systems Group	Arthur Schwalb

Contractors

General Dynamics Convair Division	Launch Vehicle
RCA Astro-Electronics Division	Spacecraft
International Telephone & Telegraph (ITT)	AVHRR
International Telephone & Telegraph (ITT)	HIRS/2
Jet Propulsion Laboratory	MSU
Ford Aeronautics Communications Corp.	SEM
TRW	ERBE

Foreign Contributors

Centre National d' Etudes Spatiales (CNES) France	ARGOS
National Search and Rescue Secretariat (NSS) Canada	Search and Rescue Repeater (SARR)
CNES/France	Search and Rescue Processor (SARP)



In this photo, technicians prepare the National Oceanic and Atmospheric Administration (NOAA-G) weather satellite for tests in a thermal-vacuum chamber at RCA Astro-Electronics, Princeton, NJ.

NAVY FLEET SATELLITE COMMUNICATIONS/ FLTSATCOM (F-7)

Launch Vehicle – The Navy FLTSATCOMs are launched aboard an Atlas Centaur (AC–66) expendable launch vehicle. After reorientation of the satellite, a solid propellant rocket motor aboard the spacecraft is fired to circularize the orbit at an Earth-synchronous altitude. This was the 66th launch of an Atlas Centaur. NASA is reimbursed for all costs of the Atlas Centaur and launch services by the Department of Defense.

Project Objectives – The objective was to place FLTSATCOM–F into a geostationary orbit above the equator to provide two-way communications, in the 240 to 400 MHz frequency band, between any two points on Earth visible from its orbital location. The spacecraft had a design life of five years.

The FLTSATCOM program is managed by the Naval Space and Warfare Systems Command. The Air Force Space Division, Los Angeles, CA, is responsible for production, launch vehicle/spacecraft integration and tracking and data acquisition.

The FLTSATCOM satellites are the spaceborne portion of a worldwide DOD network to enable communications between naval aircraft, ships, submarines, ground stations, Strategic Air Command elements and presidential command networks.

Spacecraft Description – The FLTSATCOM satellite system provides 23 ultra high frequency communication channels and one super high frequency channel. The FLTSATCOM F–7 satellite also carried an experimental Extra High Frequency (EHF) package.

Spacecraft Payload – The FLTSATCOM spacecraft consisted of two major hexagonal elements, a payload module and a spacecraft module. A majority of the electronic equipment was mounted on 12 panels that enclosed the payload and spacecraft modules.

The payload module, which was fastened to the six corners of the spacecraft module, contained the UHF and X-band communications equipment and antennas. The UHF transmit antenna was made of ribs and mesh that opened like an umbrella, and the receive antenna was a separate, deployable helix.

The spacecraft module contained the Earth sensors, apogee kick motor, attitude and velocity control, telemetry tracking and command (TT&C), electrical power distribution, and the solar array.

The solar array was folded around the spacecraft module prior to its final position in orbit where it was deployed by spring loaded hinges. It was exposed to sunlight in both the deployed and folded positions.

During the transfer orbit operations and through apogee kick motor burn, the spacecraft was spin stabilized. After apogee kick and motor burn, the spacecraft was despun, solar arrays and the UHF antenna were deployed, and the Sun and Earth were acquired. In normal on-orbit operations, the spacecraft was pointed at the center of the Earth by the Earth sensors, roll/yaw jets, and a reaction wheel. The solar array was usually normal to the orbit plane and was rotated at a uniform rate to point at the Sun. Rotation was achieved by a clocked drive with command correction available.

A redundant monopropellant hydrazine thruster system was provided for spacecraft control and velocity maneuvers. A solid propellant apogee kick motor injected the spacecraft into a circular, near-synchronous orbit.

Solar arrays and batteries interfaced with a command electrical power bus which distributed primary power to the subsystem equipment converters.

Project Results – Successfully launched from the Cape Canaveral Air Force Station, FL, on December 4, 1986.

Major Participants –

NASA Headquarters, Washington, DC

Associate Administrator for Space Flight	Admiral Richard H. Truly
Director, Expendable Launch Vehicles	Joseph B. Mahon
Manager, Atlas/Centaur Launch Vehicle	Jay A. Salmanson

Lewis Research Center, Cleveland, OH

Acting Director	Dr. John M. Klineberg
Director, Space Flight Systems	Lawrence J. Ross
Atlas/Centaur Project Manager	John W. Gibb
Chief, Space Transportation Engineering Division	Steven V. Szabo, Jr.
Deputy Chief, Space Transportation Engineering Division	Kenneth A. Adams
FLTSATCOM Mission Project Manager	Richard E. Orzechowski

Kennedy Space Center, FL

Director	Gen. F. S. McCartney
Director, Expendable Vehicle Operations	Charles D. Gay
Chief, Cargo Support CM-C10 Management Branch	James Weir

Chief, Atlas-Centaur Operations Division	James L. Womack
Spacecraft Coordinator	James B. Roberts

Contractors

General Dynamics/Space Systems Division, San Diego, CA	Atlas/Centaur Launch Vehicle
Honeywell Aerospace Division, St. Petersburg, FL	Centaur Guidance Inertial Measurement Group
Pratt and Whitney Aircraft Group, West Palm Beach, FL	Centaur RL-10 Engines Aircraft
Teledyne Industries, Inc., Northridge, CA	Digital Computer Unit/ PCM Telemetry
Rocketdyne Division, Rockwell International Corp., Canoga Park, CA	MA-5 Propulsion Systems

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GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE (GOES-7)

Launch Vehicle – A three-stage Delta 3924, provided by McDonnell Douglas, Huntington Beach, CA.

Program Overview – GOES-7, designated GOES-H prior to successful orbit, was the eighth of a series of operational spacecraft funded by the National Oceanic and Atmospheric Administration (NOAA). The prime meteorological instrument onboard is the Visible and Infrared Spin Scan Radiometer (VISSR), which had been modified to incorporate an atmospheric sounding capability. The GOES program uses spacecraft in synchronous orbit to obtain day and night information on the Earth's weather by means of Earth-imaging and sounding instruments. The full operational system requires that two geosynchronous satellites be in operation at all times and that coverage for both the Atlantic (GOES-East) and the Pacific (GOES-West) approaches as well as the North and South American land masses.

Governed by a NASA-Department of Commerce agreement dated July 2, 1973, NOAA is responsible for establishing the observational requirements and operating the system. NASA is responsible for developing and launching the spacecraft and for conducting an early orbit checkout before handing the spacecraft over to NOAA for operations.

The pilot program, Synchronous Meteorological Satellite (SMS), launched three spacecraft: two prototype spacecraft designated SMS-A and SMS-B and one operational spacecraft designated SMS-C/GOES-A. GOES-A was launched on October 16, 1975. Subsequently, GOES-B was launched successfully on June 16, 1977; GOES-C on June 16, 1978; GOES-D on September 9, 1980; GOES-E on May 22, 1981; and GOES-F on April 28, 1983. GOES-G, launched on May 3, 1986, failed to achieve orbit because of a launch vehicle failure.

GOES-H was the first geosynchronous satellite to carry search and rescue equipment as a part of the international COSPAS/SARSAT program. Principal partners in that humanitarian project are Canada, France, the Soviet Union, and the United States. GOES-H carried 406 MHz equipment designed to provide more immediate warning to rescue elements that someone was in distress.

Project Objectives – To launch the GOES-H spacecraft into a geosynchronous orbit of sufficient accuracy to enable the satellite to provide the capability for continuous observations of the atmosphere on an operational basis.

To determine the usefulness of instant alert capabilities of geosynchronous search and rescue systems and to develop and test processing techniques for geosynchronous search and rescue data.

Spacecraft Description – The GOES spacecraft consists of a spinning section and mechanically despun, Earth-oriented, helix-dish antenna assemblies. Overall spacecraft length from the S-ban omni antenna mast to the Apogee Boost Motor (ABM) nozzle aperture is 175.7 inches

(4.46 meters). The outside diameter of the spinning section is 84.5 inches (2.15 meters). The overall size and envelope are compatible with the Delta 3924 launch vehicle and its payload envelope constraints. The spacecraft dry weight is 881 pounds (400 kilograms). The spacecraft weight at launch, including sensors and ABM, will be approximately 1,851 pounds (840 kilograms), and its operational weight after separation of the ABM is approximately 1,005 pounds (456 kilograms).

The primary structural member of the spacecraft is the thrust tube located in the center of the cylinder. The atmospheric sounder is located in the center of the spacecraft. The scanning mirror, located at one end of the thrust tube, requires a clear field of view of the Earth. The radiation cooler is mounted on the other end of the instrument and requires a clear view of space with no Sun impingement over the entire operational lifetime.

The primary source of spacecraft electrical power is a body-mounted solar array. The array was designed so that normal satellite daylight operations, plus required battery charging power, can be supplied for approximately seven years.

The Spacecraft Propulsion Subsystem (SPS) is used for attitude and orbit control functions. East-West and North-South stationkeeping is maintained by the SPS. Propellant tanks contain sufficient hydrazine to support the nominal spacecraft mission life of seven years.

The spacecraft was built by Hughes Aircraft Co.

Spacecraft Payload – The satellite carried a Visible and Infrared Spin Scan Radiometer (VISSR) atmospheric sounder to provide high quality, day/night cover data, to take radiance temperatures and water vapor content at various levels; a Space Environment Monitor (SEM) for sensing energetic particles in the solar wind and radiation belts around the Earth, assessing the solar X-ray flux and measuring the magnetic field and direction in the vicinity of the spacecraft; Solar Energetic Particle Sensor (EPS) subsystem for measuring protons and alpha particles; Solar X-ray Sensor subsystem for making quantitative X-ray measurements; and Search and Rescue for monitoring 406-MHz distress signals.

Project Results – GOES--H was launched from the Eastern Test Range in Florida by a Delta 3924 launch vehicle on February 26, 1987 at 6:05 p.m. EST. The launch had been delayed from February 24 for a launch vehicle fuel leak and from February 25 because of high winds.

GOES–7 operated at 75 degrees west longitude until the failure of GOES–6, located at 135 degrees west longitude, on January 21, 1989. GOES–7 then was moved to 105 degrees west longitude, where it will remain until the launch of GOES–I in 1990.

Major Participants – Mission Management Responsibility

NASA Headquarters, Washington, DC	
Associate Administrator for Space Science and Applications	Burton I. Edelson
Deputy Associate Administrator for Space Science and Applications	Samuel W. Keller
Director, Earth Science and Applications Division	Shelby G. Tilford
Deputy Director, Earth Science and Applications Division	Ray J. Arnold
Manager, Operational Meteorological Satellite Program	James R. Greaves
Director, Communications Division	Robert R. Lovell
Director, Space Transportation Support	Joseph B. Mahon
Chief, Expendable Launch Vehicles	Peter T. Eaton
Director, Ground Networks Division	Charles T. Force
Goddard Space Flight Center, Greenbelt, MD	
Director, Goddard Space Flight Center	Noel W. Hinners
Director, Flight Projects Directorate	William C. Keathley
Manager, Metsat Project	Gerald W. Longanecker
Manager, Delta Project	William A. Russell, Jr.
Director, Mission Operations and Data Systems (Acting)	Robert E. Spearing
Director, Networks Division	Robert E. Spearing
Kennedy Space Center, Cape Canaveral, FL	
Director, Kennedy Space Center	Forrest S. McCartney
Director, Payload Management and Operations	John T. Conway
Director, Expendable Vehicles Operations	Charles D. Gay
Chief, Delta Operations Division	Wayne L. McCall

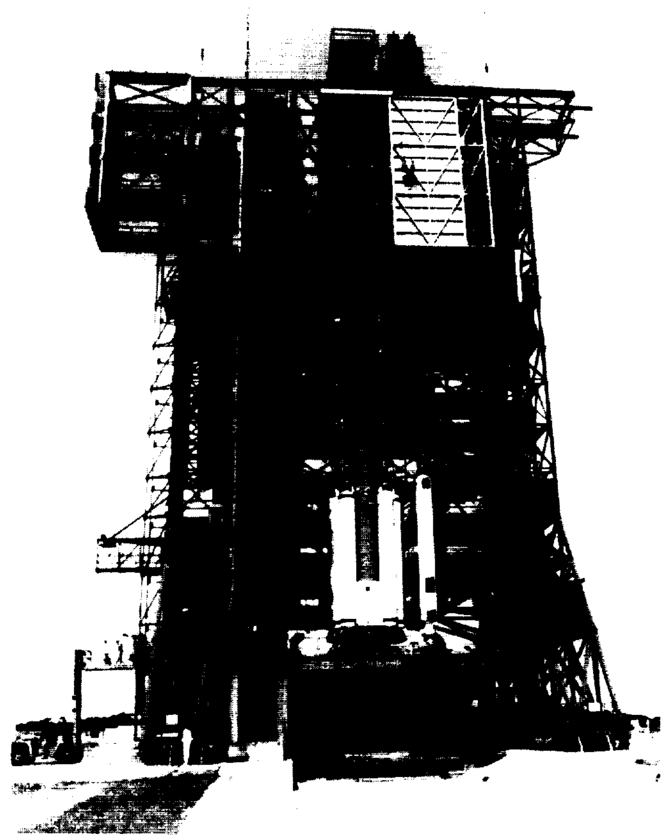
National Oceanic and Atmospheric Administration (NOAA)

Assistant Administrator	Thomas Pyke
Director, Satellite Operations	E. Larry Heacock

Contractors

McDonnell Douglas Astronautics Co.	Launch Vehicle
Hughes Aircraft Co.	Spacecraft
Panametrics, Inc.	SEM/EPS and X-Ray Sensor
Santa Barbara Research Center	Atmospheric Sounder
Ball Aerospace Systems Division	SEM/Magnetometer

A technician at Hughes Aircraft Company checks the magnetometer on the Geostationary Operational Environmental Satellite (GOES-H) meteorological satellite.



This photograph shows the third and last set of boosters being secured to the first stage of the Delta 179 launch vehicle as it is prepared for launch of the Geostationary Operational Environmental Satellite (GOES-H) meteorological satellite from complex 17-A at Kennedy Space Center, FL.

PALAPA B-2

Launch Vehicle – Delta 182, a 3920 version of the expendable launch vehicle, was used to launch Palapa B–2 into a geosynchronous orbit.

The Delta 3920 was 35.5 meters (116 feet) long including the spacecraft shroud. Liftoff weight was 1947 kilograms (4283 pounds). The first stage booster was an extended long-tank Thor powered by the Rocketdyne RS–27 engine. This engine uses hydrazine (RP–1) fuel and liquid oxygen oxidizer. Start-up thrust was assisted by six of the nine Castor strap-on rocket motors (the remaining three motors were ignited at liftoff plus 60 seconds). Pitch and yaw steering was provided by gimballing the main engine. Vernier engines provided roll control during powered flight and coast.

The second stage consisted of large diameter propellant tanks with the Aerojet Improved Transfer Injector Program (ITIP) engine. This stage was powered by a liquid propellant engine using N_2O_4 as an oxidizer and Aerozene 50 as fuel. Pitch and yaw steering during powered flight was provided by gimballing the engine. Roll steering during powered flight and coast was provided by a nitrogen gas thruster system.

Program Overview – The Palapa series of communications satellites was built for PERUMTEL, Indonesia's state-owned telecommunications company, to provide voice, video, telephone and high-speed data services to electronically link Indonesia's many islands and bring advanced telecommunications to the nation's 130 million inhabitants.

When Palapa–2 was added to Palapa–1, launched by NASA in July 1976 and operating successfully at 83 degrees E. longitude, the two-satellite system was complete. With both satellites in operation, radio, telephone and television communications through some 3,000 inhabited islands of Indonesia's 13,000 were expected to almost triple.

Indonesian officials selected satellite communications because of the tremendous problems and expense in establishing conventional land and underwater communications links. It was not economically or physically possible to install wires and microwave towers over thousands of miles of ocean, islands, hills, and forests.

Kennedy Space Center, FL is responsible for launch operations. Prime contractor for the Palapa spacecraft is Hughes Aircraft Co., El Segundo, CA.

Spacecraft Payload – The Palapa B–2 was the second generation of the Palapa series of communications satellites. The spacecraft would be known as Palapa B until it reached its geosynchronous orbit of 35,800 kilometers (22,300 miles) above the equator, where it would be renamed Palapa 2. Once there, the satellite would drift at the rate of two or three degrees a day to its on-station position at 77 degrees E. longitude.

Both Palapa spacecraft are identical to the Canadian Anik and Western Union's WESTAR with the exception of the antenna which has been modified to provide optimum illumination of the Indonesian land mass.

The 12-transponder satellite has an average capacity of 4,000 voice circuits of 12 simultaneous color television channels. It measures 3.7 meters (11 feet) in height (including the antenna) and 1.9 meters (6.2 feet) in diameter. The antenna is a shaped-beam solar transparent 1.5 meter (4.8 feet) diameter parabolic dish.

Launch weight of the spacecraft is 575 kilograms (1,267 pounds) including the apogee kick motor which weighs 293 kilograms (645 pounds). Design lifetime is seven years.

Project Results – Palapa B-2 was launched into a geosynchronous orbit aboard Delta flight 182 on March 20, 1987, at 6:22 p.m. (EST) from Cape Canaveral Air Force Station, FL.

Major Participants –

<u>NASA Headquarters, Washington, DC</u>

Associate Administrator for Space Flight	John F. Yardley
Director of Expendable Launch Vehicle Programs	Joseph B. Mahon
Manager, Delta Programs	Peter T. Eaton

<u>Goddard Space Flight Center, Greenbelt, MD</u>

Director	Dr. Robert S. Cooper
Deputy Director	Robert E. Smylie
Director of Projects Management	Dr. William C. Schneider
Delta Project Manager	Charles R. Gunn
Deputy Delta Project Manager, Technical	William R. Russell, Jr.
Chief, Mission Analysis and Integration Office, Delta Project	Robert Goss
Delta Mission Integration Engineer	William Burrowbridge
Director of Networks	Tecwyn Roberts
Director of Mission and Data Operations	Albert G. Ferris
Network Support Manager	Richard Sclafford

Network Director	Dale Call
Network Operations Manager	John Walker
Network Operations Manager	Wayne Murray
NASA Communications Engineer	Pat McGoldrick
Kennedy Space Center, Cape Canaveral, FL	
Director	Lee R. Scherer
Deputy Director	Miles Ross
Director, Space Vehicles Operations	Dr. Walter J. Kapryan
Director, Expendable Vehicles	George F. Page
Chief, Delta Operations Division	Hugh A. Weston, Jr.
Chief Engineer, Delta Operations	Wayne L. McCall
Spacecraft Coordinator	Lawrence F. Kruse